A POOL BASED ELECTRICITY MARKET DESIGN FOR MALAYSIA ELECTRICITY SUPPLY INDUSTRY

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Electrical - Power)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

NOVEMBER 2008

To my beloved supportive mama and dad

ACKNOWLEDGEMENT

First and foremost, I would like to express my gratitude to Allah s.w.t, the Almighty and the Greatest Creator for His never ending blessings and help. Without His permit, I would not be able to reach up to this level.

In preparing this project report, I was in contact with several people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts. In particular, I would like to convey my deep sense of appreciation to my project supervisor, Assoc. Prof. Dr. Mohammad Yusri bin Hassan for his encouragement, guidance, helps, and advices throughout the progress of the project.

I am deeply indebted to my father, Arifin bin Mahmud, my mother, Alfiah binti Mukhtaram, and siblings; Aida Zureen and Aidid Shahrulzaman, for their love, 'day and night' motivations, and supports given throughout so many years. My warm thanks to mama and dad for funding my studies and always be there for me, only He can reward all the sacrifice that you have done for me.

Last but not least, my sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. May Allah s.w.t will bless all of you.

ABSTRACT

In the era of acheiving the target of restructuring of electricity supply industry which had began in early 20th centuries, Malaysian Electricity Supply Industry (MESI) has aimed to change its structure to a wholesale market model in 2005. The first step taken in 1992 is by introducing the Independent Power Producers (IPPs) and since then MESI had applied the Single Buyer Model which had continued until this moment of time. Tenaga Nasional Berhad (TNB) acts as the power off taker that is produced by all IPPs and TNBG. However, this model does not provide transparent competition as it supposed to. TNB on the other hand, has suffered massive profit erosion as a result of TNB's payouts to IPPs based on a monthly rate regardless of electricity usage. This is based on the initial IPPs that were awarded licences to pursue the IPP model under Power Purchased Agreement (PPA) that would spans periods of up to 21 years. This thesis proposed an alternative electricity market model for MESI, which could be applied in order to carry on the MESI previous plan towards restructuring**.** The proposed model is designed to include the Pool Trading model with several market policies in order to accommodate a fair competitive trading between power producers and produce win-win situation to all involved parties especially to IPPs. The analysis in the proposed model illustrates guaranteed incomes for all IPPs and this might influenced them to renegotiate the terms in the agreement.

ABSTRAK

Di dalam mencapai sasaran ke arah penstrukturan semula industri bekalan elektrik yang bermula sekitar abad 20-an, Industri Bekalan Elektrik Malaysia (MESI) telah merancang untuk menukar strukturnya kepada model pasaran borong pada tahun 2005. Langkah pertama yang diambil pada tahun 1992 ialah dengan memperkenalkan Penjana Kuasa Bebas (IPP) dan sejak itu MESI telah mengaplikasikan model pembeli tunggal sehingga kini. Tenaga Nasional Berhad (TNB) bertindak sebagai pembeli tunggal kepada semua bekalan elektrik yang dihasilkan oleh IPP dan TNBG. Walau bagaimanapun, model ini tidak menjalankan persaingan seperti yang sepatutnya. TNB sebaliknya telah mengalami kemerosotan keuntungan yang tinggi berikutan dari tanggungjawabnya untuk membayar kadar bulanan tetap tanpa mengambil kira samada terdapat penggunaan elektrik atau sebaliknya. Ini berdasarkan kepada penjana kuasa bebas (IPP) terawal yang diberi lessen untuk melaksanakan model dibawah Perjanjian Pembelian Elektrik (PPA) yang mempunyai jarak jangka masa sehingga 21 tahun. Tesis ini mencadangkan satu model pasaran alternatif yang boleh diaplikasi dalam meneruskan rancangan asal MESI terhadap penstrukturan semula. Model cadangan ini direka untuk merangkumi model jual beli berpusat bersama beberapa polisi pasaran dalam memastikan adanya persaingan yang adil antara semua penjana elektrik dan memberi kepuasan kepada kesemua pihak yang terlibat terutamanya kepada IPP. Analisis terhadap model cadangan ini menggambarkan jaminan pendapatan bagi setiap penjana bebas yang mana ini mungkin akan mempengaruhi mereka untuk berunding semula mengenai terma-terma di dalam perjanjian tersebut.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

EC	-	Energy Commission
IMO	-	Independent Market Operator
ISGO	-	Independent System Grid Operator
IPP	-	Independent Power Producer
MESI	-	Malaysia Electricity Supply Industry
PAB	-	Pay as Bid Scheme
PPA	-	Power Purchase Agreement
TNB	-	Tenaga Nasional Berhad Sdn. Bhd.
TNBD	-	Tenaga Nasional Berhad Distribution Sdn. Bhd.
TNBG	-	Tenaga Nasional Berhad Generation Sdn. Bhd.
UP	-	Uniform Price Scheme

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Overview of Electricity Supply Industry (ESI)

For almost a century, each sector in the electricity supply industry (ESI) which is generation, transmission and distribution were thought to be a natural monopoly. It is also has been vertically integrated within a utility and can be either, investor-owned and state-regulated or owned by the local municipality. But for Samuel Insull, the president of National Electric Light Association in 1890s, he had claimed that the business should be regulated at the state level [1]. During that period, consumers had no choice of buying the electrical energy except from the utility that held the monopoly for the supply of electricity in the area where these consumers were located. If the utilities were vertically integrated, this means that the utility generated the electrical energy, transmitted it from the power plants to the load centers and distributed it to individual consumers. In other cases, the utility from which consumers purchased electricity was responsible only for its sale and distribution local area. This distribution utility in turn had to purchase electrical energy from a generation and transmission utility that had a monopoly over a wider geographical area. Irrespective of ownership and the level of vertical integration, geographical monopolies were the norm.

In early 1980s, some economics started arguing that the monopoly status of electric utilities had removed the incentive to operate efficiently and encouraged unnecessary investments. They also argued that the cost of the mistakes that private utilities made should not be passed on to the consumers. Public utilities, on the other hand, were often too closely linked to the government. Politics could then interfere with good economics. For example, public utilities were treated as cash cows, and others were prevented from setting rates at level that reflects costs or were deprived of the capital that they needed for essential investments. However the status had remained the same until the expansion of transmission technology, which mainly for purposes of reliability had brought new possibilities for trade and competition.

Later on, the electricity supply industry (ESI) had undergone a major transition worldwide, as new technology and attitudes towards utilities is being developed and changed. Basically, the objectives of these restructuring are to enhance efficiency, to promote competition in order to lower costs, to increase customer choice, to assemble private investment, and to merge public finances. The tools of achieving these objectives are the introduction of competition which is supported by regulation and the encouragement of private participation. Changes in the ESI structure had introduced a number of electricity market models which is designed appropriately with its local condition. These market models are the single buyer model, the pool market model, the bilateral contract model and hybrid/multilateral model.

Malaysia Electricity Supply Industry (MESI) on the other hand, had done the first step towards restructuring by encouraging private investors in producing electrical energy since 1992 following a nationwide power blackout and serious interruptions and rationing. Beside that, the introduction of Independent Power Producers (IPP) had aided TNB to overcome the electricity shortage issue and enlarge the electrical energy reserve margin. The competition is valid only in generation sector while the transmission and distribution sector are still with TNB. This electricity market model is also known as the

single buyer model and since then, MESI had applied this market model. Currently, there are 14 IPPs in the Peninsular of Malaysia and the electrical energy is sold to the TNB on a fixed rate based on the power purchase agreement (PPA). This agreement which last for 21 years is signed between the TNB and IPP for the purpose of market risks protection. The restructuring is supported with the existence of Energy Commission (EC) which is an electrical regulator in Malaysia. EC is obliged to not only design the appropriate electricity market model but also to setup suitable policies and regulation related to electricity industry.

1.2 Objectives of the Project

The objectives of this project are:-

a) To study deeply the structure and economics aspects of market models for Single Buyer and Pool Market Model
b) To analyze and compare the economic benefits between these two model from the viewpoint of the power producers
c) To design a Pool Market Model for Malaysian Electricity Supply Industry (MESI)

1.3 Scope of Project

Changes in the electricity supply structure have led to variety types of electricity market models such as Single Buyer Model, Pool Market model, Bilateral Contract Model and Hybrid/Multilateral Model. Therefore, this project is focusing on the Single Buyer and the Pool Market model. This is due to the facts that the existing Malaysia Electricity Supply Industry (MESI) is applying the Single Buyer Model and this project aims to design the Pool Market Model. Examples of the application for these two market models will be analyzed and the results found thus will aid the design of Pool Market model. The electricity trading that is being considered is only up to the transmission level. Consequently, the business is only between the generator as the seller and distributor as the buyer or customers without taken into account the end user.

1.4 Problem Statement

In 1992, following a nationwide power blackout, and a series interruptions and rationing caused the government to conduct an immediate assessment of the nation's power generation industry. As a result of rapid development of the national economy in the preceding years, it appeared the country was unable to cater for the parallel growth in demand for power. To narrow this widening gap, and under its successful privatization agenda, the Government identified the Independent Power Producer (IPP) model, whereby the capital-intensive development of new generation assets could be outsourced to the private sector. This was became the initiative that would deliver the immediate national power security needed to maintain GDP growth whilst not putting unnecessary pressure on Tenaga Nasional Berhad (TNB) resources.

The initial IPPs were awarded licences to pursue the IPP model under power purchased agreements (PPAs) that would span periods of up to 21 years and govern how the IPP would construct, purchase and/or use of fuel, operate and sell energy produced. In this agreement, the power off taker which is TNB had agreed to pay to types of payment; energy and capacity payment. The energy payment is done based on the electricity consumed by TNB. Meanwhile, the capacity payment which is paid monthly regardless the usage performs two main roles. This type of payment provide extra revenue to the generator, to cover the capital and other fixed costs which are not covered by the energy price. It also provides incentives for generators to be available at times when the system needs generation capacity. As the power off taker TNB has to bear the high expenses and this has made TNB suffered massive profit erosion.

TNB is also hit by the increasing of fuel cost. The government is bearing the burden of rising cost due to the subsidies. But the IPPs are not sharing any of these burdens. When the demand getting slower, TNB could not sustain the capacity payment as it is fixed. As it stands, electricity tariff have gone up for the end users. Consequently, consumers also faced risks as they depend on current market situation. Hence, a new market design is required so that the consumers pay reasonable price, TNB makes reasonable profit and IPPs as well.

1.5 Methodology

In designing the Pool Market model for Malaysia Electricity Supply Industry (MESI), the following steps are undertaken:-

a) Perform depth literature review on existing market model for Single Buyer and Pool Market model that are applied in other countries
b) Understand the fundamental concepts for both market models
c) Analyze the structure and operation for each market models
d) Design Pool Market Model based on MESI local condition by formulating the mathematical equation which represent the generation revenue
e) Suitable policies is created based on real time supply and demand electricity daily curve in Peninsular Malaysia in order to provide a fair trading
f) Conduct comparative analysis on the generation revenue for the Single Buyer and Pool Trading Model by using Matlab Simulation approach

Figure 1.1 below shows the project's flowchart that explains the whole process for the project

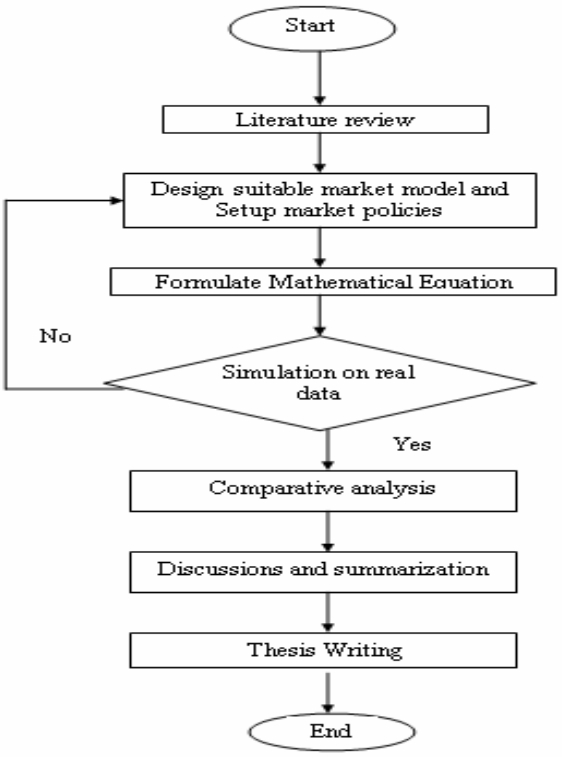

Figure 1.1: Project flowchart

1.6 Thesis Organization

Chapter 1 describes the overview of the project including the objective, the problem statement and methodology throughout the project. Meanwhile, Chapter 2 outlines the fundamental information on the restructuring of electricity supply industry (RESI) including a few example of the restructuring in advanced and developing countries. The structure of RESI also is being explained in this chapter.

Chapter 3 represents the depth explanation of current situation for Malaysia Electricity Supply Industry (MESI) which applied the single buyer model at this moment of time. It consists of the market players, types of payment, and related current issues. Other than that, this chapter also discussed the frame work that has been planned for Malaysia towards restructuring and the progress status.

A pool based market design for MESI is presented in Chapter 4. Two types of market settlement in pool trading model which is one sided pool and two sided pool are being discussed in this chapter. Beside that, a hybrid model that able to overcome several issues arise throughout the process of applying the pool trading model are also included.

Chapter 5 represents about the case study conducted in order to compare the proposed model with the existing model in term of the generation revenue. Results simulation and analysis are discussed in Chapter 6. Finally, Chapter 7 concludes the project and suggests several future works that should be done.

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